CLAIMS

We Claim:

1. A label-independent detection system for detecting biological or chemical agents, the detection system comprises: 1) a substrate surface having a sensing region with a bio- or chemo-responsive layer; 2) an optical interrogation apparatus for monitoring said bio- or chemo-responsive layer, said optical interrogation apparatus comprising a grating-coupled waveguide structure, a light source, an optical delivery system, and a detection instrument, wherein more than one direction of propagation is used in said waveguide to generate a sensor response for either a given angle or wavelength.

2. The detection system according to claim 1, wherein for a given angle or wavelength, two resonances exists as a result of light propagation in two different, symmetrical directions in the waveguide.

3. The detection system according to claim 1, wherein said sensor response is generated simultaneously using more than one direction of propagation.

4. The detection system according to claim 1, wherein said sensor response is generated in sequence using more than one direction of propagation.

5. The detection system according to claim 1, wherein an angular shift as measured using both propagation directions as a function of refractive index change greater than a sensitivity obtainable from using only one direction of propagation.

6. The detection system according to claim 5, wherein an angular shift as measured using both propagation directions as a function of refractive index change improves interrogation signal-to-noise sensitivity of said apparatus by a factor of at least about $\sqrt{2}$.

7. The detection system according to claim 1, wherein a spectral shift as measured using both propagation directions as a function of refractive index change improves an observed signal to noise ratio in said system by a factor greater than that achievable from using only one propagation direction.

8. The detection system according to claim 7, wherein a spectral shift as measured using both propagation directions as a function of refractive index change improves an observed signal to noise ratio in said system by a factor of at least about $\sqrt{2}$.

9. The detection system according to claim 1, wherein signal from different propagation directions are used to mitigate system sensitivity to environmental perturbations.

10. The detection system according to claim 9, wherein a difference in resonant peak locations is insensitive to an angular position of said sensor.

11. The detection system according to claim 9, wherein the average of resonant peak locations is insensitive to an angular position of said sensor.

12. The detection system according to claim 1, wherein signal from different propagation directions, together with mathematical corrections for waveguide dispersion, are used to mitigate system sensitivity to environmental perturbations.

13. The detection system according to claim 12, wherein an average of resonant peak locations, modified by an appropriate waveguide dispersion correction, is insensitive to an angular position of said sensor.

14. The detection system according to claim 1, wherein said system further includes an air-fluid delivery system, comprising either macro or micro-fluidic passages designed to deliver biological or chemical analytes to said sensing region.

15. A method of detecting biological or chemical agents, the method comprises: providing a sensor system having a evanescent-field sensing region comprising a substrate surface having at least a bio- or chemo-responsive layer; generating a double resonance within a grating-coupled waveguide of said system for either a given angle or wavelength; exposing an individual sensing region to an environment with analytes; and monitoring a response from said sensor system.

16. The method according to claim 15, wherein an angular shift as measured using both propagation directions as a function of refractive index change doubles (2X) interrogation sensitivity of said apparatus.

17. The method according to claim 15, wherein a spectral shift as measured using both propagation directions as a function of refractive index change improves an observed signal to noise ratio in said system by a factor of at least about $\sqrt{2}$.

18. The method according to claim 15, wherein said method uses either a mean or difference of the resonance modes in a detection system.

19. The method according to claim 15, wherein said substrate is modified with one or more materials, which enhance stable immobilization of said bio- or chemo-responsive layer.

20. A biosensor comprising: 1) a substrate surface having a sensing region with a bio- or chemo-responsive layer; 2) an optical interrogation apparatus for monitoring said bio- or chemo-responsive layer, said optical interrogation apparatus comprising a grating-coupled waveguide structure, a light source, and an optical delivery system, wherein more than one direction of light propagation is used in said waveguide to generate a sensor response for either a given angle or wavelength, and a signal from different propagation directions are used to mitigate sensitivity to environmental perturbations.

21. The biosensor according to claim 20, wherein a spectral shift as measured using both propagation directions as a function of refractive index change improves an observed signal to noise ratio in said system by a factor greater than that achievable from using only one propagation direction.

22. The biosensor according to claim 20, wherein an angular shift as measured using both propagation directions as a function of refractive index change greater than a sensitivity obtainable from using only one direction of propagation.

23. The biosensor according to claim 22, wherein an angular shift as measured using both propagation directions as a function of refractive index change improves interrogation signal-to-noise sensitivity of said apparatus by a factor of at least about $\sqrt{2}$.

24. The biosensor according to claim 22, wherein an angular shift as measured using both propagation directions as a function of refractive index change doubles (2X) interrogation sensitivity of said biosensor.